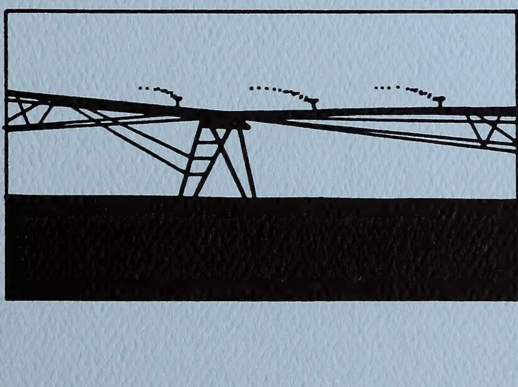
IRRIGATION AND RESOURCE MANAGEMENT DIVISION



Applied Research Report

1995 - 1996

Alberta
AGRICULTURE, FOOD AND
RURAL DEVELOPMENT

1995-96

APPLIED RESEARCH REPORT

IRRIGATION AND RESOURCE MANAGEMENT DIVISION

ALBERTA AGRICULTURE, FOOD AND RURAL DEVELOPMENT

April 1996

PREFACE

The Irrigation and Resource Management Division Annual Applied Research Report is a collection of progress and final summary reports. The research is carried out by staff members of the Division and private consultants retained under contract. Research projects vary from detailed tests to field surveys; from irrigation to conservation topics.

The reports are limited in length and summarize the highlights. The detailed data and information are available from the individual researchers. The reports have been grouped according to subject matter. The authors are responsible for the contents of the report.

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ACKNOWLEDGEMENTS

I would like to thank the staff members who carried out the research and prepared the reports in this 1995-96 edition of the Applied Research Report of the Irrigation and Resource Management Division. I acknowledge the great effort to plan and carry out these projects. I also appreciate the encouragement and support provided by their supervisors. On behalf of all, I thank the farmers, irrigation districts, agriculture research associations, agriculture organizations and Agricultural Service Boards for their cooperation.

Special thanks to Carly King, Cheryl Osborne and Hank Vanderpluym for compiling and formatting the report.

Brian L. Colgan, Director
Irrigation and Resource Management Division

TABLE OF CONTENTS

IRRIGATION - WATER APPLICATION

Fall Irrigation Study - 1995

Objective:

To examine the effects of varied fall irrigation applications and cultivation practices on spring soil moisture conditions within a one metre root zone.

Background:

Fall irrigation is an important water management tool in Alberta. It has the potential to reduce the May workload by transferring some of the irrigation to the previous fall. Fall irrigation can build soil moisture reserves to acceptable levels for the next growing season and ensure sufficient moisture for optimum crop growth until spring irrigation can be applied.

Division Key Results:

This project will contribute to improved irrigation water management and conservation. Fall irrigation, properly managed, will benefit both the producer and the irrigation district.

Project Description:

The time frame for the study is the overwinter period from October 13, 1994 to April 15, 1995.

The project is located in the SE 17-09-11-W4, approximately 20 km south of Bow Island. The plot area for the project was split into two parts: half of the area was in barley stubble and the other half of the area was cultivated. A randomized plot design was used in each of the areas. Three different irrigation treatments and a dryland plot were replicated three times in each area. The size of each plot was 6.1 m x 6.1 m (20' x 20') with a 9.15 m (30') buffer zone around each plot.

Prior to the study period, a 1.5 m long aluminum access tube was installed centrally across each plot. Using a Campbell Pacific neutron probe, soil moisture readings were taken at 25 cm intervals to a depth of 1.5 m. The 100-150 cm depth was monitored for possible deep percolation of soil moisture beyond the 0-100 cm zone. Soil moisture monitoring was performed on a weekly basis during late fall and early spring and as weather or field conditions permitted during winter.

Project Results:

The fall of 1994 was wet with 57.9 mm of precipitation in October, 26.2 mm of which fell during the initial plot irrigation. As a consequence, irrigation was terminated and the overwinter performance of the stubble and cultivated areas was compared. Due to the substantial precipitation received prior to freeze up (90% of the total precipitation was in October and November), both the stubble and the cultivated sites entered the overwinter period at or near field capacity levels.

Seasonal evaporative losses were largest for the cultivated treatment. The cultivated treatment had a total loss of soil moisture of 40.7 mm and the stubble treatment a total loss of 35.0 mm. The total loss of soil moisture includes 77.5 mm of overwinter precipitation.

The amount of water lost on a daily basis was 0.23 mm/day for the stubble treatment and 0.26 mm/day for the cultivated treatment. The amount of water lost under cultivated conditions was 16.3% greater than stubble.

Overwinter soil moisture levels increased 22.2 mm and 20.5 mm for the cultivated and stubble treatments respectively. This represented an 8.3% greater soil moisture increase for the stubble treatment. Neither of the treatments resulted in water movement below the 0-100 cm zone.

Conclusions:

This was the fourth year of the study. Precipitation of 77.5 mm for the overwinter interval was near the seasonal average of 77.9 mm. There was curtailed irrigation on both stubble and cultivated plots due to substantial precipitation at project start-up.

Both cultivated and stubble sites showed soil moisture increases in the spring. The cultivated treatment started and ended with slightly higher soil moisture than the stubble treatment, but the stubble treatment demonstrated a marginally greater soil moisture increase during the overwinter period.

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Irrigation Branch AAFRD

IRRIGATION - WATER APPLICATION

Irrigation Block Study

Objective:

The study involves four components:
1) To calibrate the Irrigation Requirements District Model using field data from two irrigation blocks, Bow River Irrigation District (B.R.I.D.) and Lethbridge Northern Irrigation District (L.N.I.D.).
2) From the information collected, evaluate the irrigation districts' present water allocation criteria.
3) To develop and test new management strategies to manage inflow, reduce return flows and improve on-farm use.
4) To determine the quality of water entering and leaving two irrigation blocks and returning to the rivers.

Background:

In May 1990, Alberta announced a water management policy for the South Saskatchewan River basin that established guidelines for irrigation expansion. The announcement stated that "these guidelines for limiting irrigation expansion will be reviewed in the year 2000." In order to make proper water management decisions, accurate and complete information regarding water supply, crop water use and return flow databases for the irrigation districts is required. The current review process of the Water Resources Act has highlighted many policy issues with potential implications for water management within the irrigation districts. This new water management policy reflects the increasing pressure on the resource. Irrigation is the largest licensed user of water in the Province and is often perceived by the public and many policy makers to be wasteful and beneficial to only a small group of people. In reality, the benefits are more general to the province and the country as a whole.

Division Key Results:

This project will contribute to the improvement of irrigation water management and conservation. With irrigation being the largest water user in the South Saskatchewan River Basin, it is extremely important that water diverted for irrigation is conveyed, stored and used wisely by all.

Project Description:

The block selected in B.R.I.D., known as K-5, is located 15 km northwest of the Town of Vauxhall and was completely rehabilitated in 1991. All water entering and leaving the block is measured using electronic dataloggers complete with water level equipment. Data are collected at 20 minute intervals throughout the irrigation season. Dataloggers were installed before water was released into the system. Cutthroat flumes constructed of pressure treated plywood were installed in the spring of 1994. These flumes were installed in most farm head ditches used for gravity irrigation. Electronic dataloggers complete with water level equipment were installed prior to irrigation. Propeller type flow meters have been installed on 10 sprinkler systems.

The block selected in L.N.I.D., known as J-12, is located near the Town of Iron Springs. The lateral was rehabilitated in 1985. In the spring of 1994, L.N.I.D. installed a broad-crested weir just downstream of the turnout from the main canal to measure water coming into the block. This block is entirely sprinkler irrigated. Propeller type flow meters have been installed in all farm pumping sites, where practical. Where flow meters were not practical, hours meters have been installed. Hours meters will enable us to keep track of the amount of time the irrigation farmers were operating their systems. Automated weather stations have been set up at both locations to collect temperature, solar radiation, rainfall, relative humidity and wind travel data.

Project Results:

In both areas, the mean temperature ranged from 5% to 10% below the average throughout the crop growing season. For the same time period, precipitation was above normal. In the L.N.I.D., precipitation for the months of May and June were 117% and 113% above normal. The month of July was 53% above normal. In the B.R.I.D., the months of May and July were 95% and 87% above normal.

Table 1 gives a brief summary of the amount of water diverted into each block and the amount of return flow. During the irrigation season, 24% (B.R.I.D.) and 27% (L.N.I.D.) of the water diverted ended up in the return flow channels. To ensure the accuracy of the cutthroat, a pygmy current meter was used to check the flow. Where propeller type flow meters were installed, a Polysonic flow meter was used to check the accuracy.

TABLE #1 ON-FARM	INFLOW (ac ft)		RETURN FLOW (ac ft)	
	SEASON	FALL IRR.	SEASON	FALL IRR.
BRID K5	3733.4	324.9	897.7	308.1
LNID J12	2563.7	667.4	695.9	333.6

No calibration work of the irrigation district model has been carried out. This model is currently being updated by Phoenix Engineering in Calgary; to be completed by March 31, 1996. Data collected for 1994 and 1995 are to be used to calibrate the Irrigation Requirements Model once the re-write has been completed.

Conclusions:

None. Purpose of the model is to assist irrigation districts in making better water management decisions. As water becomes a limiting factor, districts will be forced into fine tuning their water management practices even further.

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IRRIGATION - PRODUCTION

Yield of Soft Wheat Irrigated with Saline-Sodic Water

Objective:	Determine the effect of alternating different saline-sodic irrigation waters with rain on the yield of Soft White Spring Wheat.
Background:	Saline irrigation waters contain salts [measured by electrical conductivity (EC)] which may be concentrated in the soil and reduce water uptake by plants. This salt-induced water stress can reduce yield. Sodic waters contain high levels of sodium [measured by sodium adsorption ratio (SAR)]. High sodium causes breakdown of soil structure, resulting in reduced infiltration and percolation of water. In prairie environments, where rain supplies about half the water requirement of irrigated crops, rain received on a soil initially equilibrated with saline-sodic water may cause rapid deterioration of soil structure and reduced crop yield. Conversely, rain may reduce the buildup of salts, which could enhance crop yield. Present-day water quality guidelines do not address the possible effect of rain.
Division Key Results:	This project contributes to sustaining soil quality by developing guidelines for the suitability of saline-sodic irrigation water.
Project Description:	Yield was determined for five consecutive soft wheat crops (variety AC Reed) grown in a greenhouse. Soft wheat was seeded and germinated with rainwater. Irrigations after germination alternated between irrigation waters and rain. The irrigation waters ranged in quality from conventional water (Water 1 - W1), which is non-saline and non-sodic, to moderately saline and sodic (Water 7 - W7). Progression from W1 to W7 represents an increase in the salinity and sodicity of the water and increasing hazard from use of the water. Stability of soil aggregates was measured after harvest of each crop to determine treatment effects on soil structure. The experiment was a randomized complete block design with three replicates and was analysed with an analysis of variance.
Project Results:	Grain yield was similar between irrigation waters for the first three crops (Fig. 1a). Yield was significantly lower in the fourth and fifth crops with W6 (EC 3, SAR 15) and W7 (EC 3, SAR 20) compared to conventional irrigation water (W1). Yield also tended to be lower with the remaining saline-sodic waters, except W2. Reduced yield parallelled reduced consumptive water use and reduced emergence. The reduced emergence resulted from ponding of rain on the soil surface following crop seeding. We also found stability of soil surface aggregates decreased with increasing salinity and sodicity of irrigation water (Fig. 1b). This effect was observed after the first crop.

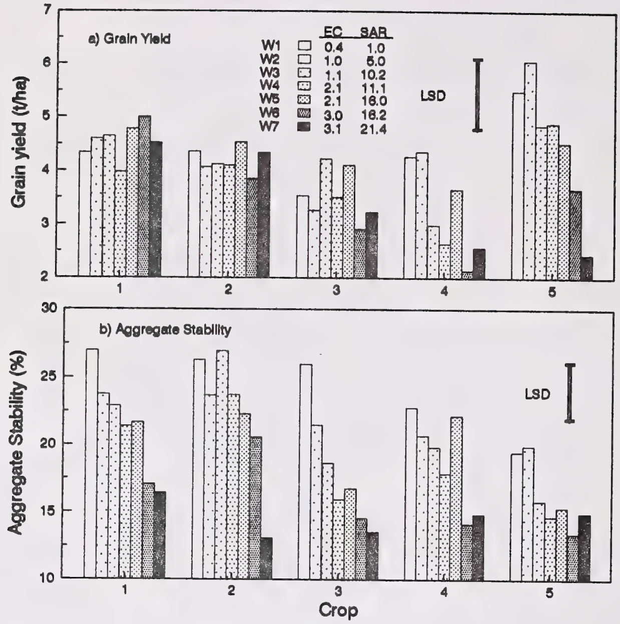

Figure. 1a) Grain yield and b) surface soil aggregate stability for five consecutive soft wheat crops as affected by irrigation water quality.

Conclusions:

Salinity and sodicity of the irrigation water did not cause reduced yield of soft wheat during initial years under high-frequency irrigation. Salinity levels were only gradually increased with successive crops, and levels were below the threshold for crop salt tolerance. Crop yield decreased abruptly after the third crop because of reduced emergence associated with low infiltration rates and ponding of rain on the soil surface. This is believed to have resulted from high SAR of some irrigation waters. Aggregate stability tests, which identified a potential effect of the water prior to declines in crop yield, may be a promising test for screening irrigation waters for their suitability for irrigation.

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WATER QUALITY

Manure and Nutrient Management to Sustain Groundwater Quality in Alberta

Objectives:	To develop improved manure and nutrient management practices to maximize the economic value of manure amendments and to minimize effects on shallow groundwater quality.
Background:	Nitrate contamination of groundwater has been attributed to a number of farming practices, including improper handling and disposal of manure. Disposal of manure from feedlots is a growing problem, particularly in areas where high densities of sizeable operations exist. Field research and monitoring in Alberta have shown high nitrate levels in groundwater where high rates of manure were applied to soil. Effective environmental manure management practices are needed for the livestock industry as the industry expands in Alberta.
Division Key Results:	This study will contribute to improved stewardship of natural resources regarding soil quality and water quality.
Project Description:	Four field research sites were established: two in 1993 in the Lethbridge Northern Irrigation District under irrigated conditions, and two in 1994 in central Alberta under dryland conditions. The main difference between the two sites at each location was soil type. Treatments included a control, three N fertilizer rates (60, 120, 180 kg ha^{-1}), four manure rates (20, 40, 60, and 120 Mg ha^{-1}), and the same four manure rates treated as best management practices with respect to N requirement of the test crop (silage barley). The treatments were replicated five times and arranged in a randomized complete block design. Manure was applied in the fall of 1993, 1994 and 1995 at the southern Alberta sites, and in the fall of 1994 and 1995 at the central Alberta sites. Barley was seeded in 1994 and 1995 at the southern Alberta sites and in 1995 at the central Alberta sites. Soil and groundwater chemistry and barley yields were measured. This study will continue for one more growing season (1996).
Project Results:	This report highlights some preliminary results from the manure treatments with respect to soil and groundwater nitrate-N levels. Southern Alberta Sites (Irrigated) After two annual applications of manure, soil nitrate-N accumulated in the surface soil layers (0-30 cm), with greater amounts under the higher manure rates. This was particularly noticeable at the medium-textured site where soil nitrate-N was low (< 10 kg N ha^{-1}) and similar throughout the measured profile at the beginning of the study. After two manure applications, the amount of nitrate-N in the

0-15 cm layer increased to about 35 kg N ha^{-1} at the highest manure rate. Groundwater nitrate-N concentrations were high prior to treatment applications, especially at the coarse-textured site. Groundwater nitrate-N content ranged from 8 to 98 mg N L^{-1} at the coarse-textured site, and from near zero to 35 mg N L^{-1} at the medium-textured site. There were no treatment effects on groundwater nitrate-N content, except in 1995 at the coarse-textured site where an increase from 40 to 80 mg N L^{-1} was observed for the highest manure rate over a five-month period. The water table was about 2 m below the soil surface at both sites.

Central Alberta Sites (Dryland) There was no apparent accumulation of nitrate-N in the soil profile or groundwater 11 months after one application of the manure rates at either site. Groundwater nitrate-N content remained below 4 mg N L^{-1} at both sites throughout the measured period. The water table was about 6.5 to 7 m below the soil surface at both sites.

Conclusions:

A field study was continued to evaluate the effects of manure and nutrient management practices on groundwater quality. The surface soil nitrate-N content increased after two manure applications at the southern Alberta sites. There was no treatment effect on soil nitrate-N at the central Alberta sites. Manure application had no effect on groundwater nitrate-N content, except possibly at the southern Alberta coarse-textured site where groundwater nitrate-N content increased with the highest manure rate in 1995.

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Supporting Agencies:

Canada-Alberta Environmentally Sustainable Agriculture Agreement

WATER QUALITY

Groundwater Return Flow in the Lethbridge Northern Irrigation District

Objectives:

1) To characterize groundwater flow and quality in the Battersea drainage basin.
2) To predict the effect of excess nitrate in the study area on groundwater and surface water quality over the long term.

Background:

Nitrate from fertilizer and manure has resulted in groundwater contamination in some areas of North America. The drinking water guideline has been set at 10 mg L^{-1}, due to potential health effects from ingestion of excess nitrate. The Battersea drainage basin of the Lethbridge Northern Irrigation District, located about 15 to 20 km north of Lethbridge, has one of the highest densities of intensive livestock and poultry feeding operations in Alberta. Shallow aquifers such as those in the Battersea basin are relatively susceptible to contamination. Discharge of contaminated groundwater may have the potential to decrease the quality of surface water.

Division Key Results:

Understanding the source and fate of nitrate in groundwater in the study area will allow us to develop guidelines and best management practices for the handling of fertilizer and manure in the study area. This will help to maintain and improve water quality.

Project Description:

This four year project started in 1993, when piezometer nests (sets of water wells to test the groundwater at different depths) were installed at 23 locations along a northwest- to southeast-trending transect between Blackspring Ridge and the Oldman River. The research team is now monitoring the piezometers to determine groundwater flow and quality in the basin, and the source and fate of nitrate. Groundwater flow and transport modelling will be conducted to predict the potential effect of excess nitrate on groundwater and surface water over the long term.

Project Results:

Groundwater flow is concentrated in the post-glacial and interglacial sand and silt, due to the very low permeability of the lower glacial till (Figure 1). Groundwater discharge areas occur in depressional areas and along the banks of the Oldman River. Nitrate levels up to 250 mg L^{-1} were detected in oxidized till and interglacial clay at piezometer nests 2, 5 and 6 (Figure 1), at depths between 6 and 13 m below ground. This nitrate is not associated with high nitrate at the water table, and stable isotope data suggest much of the groundwater in the high-nitrate zones entered the system before 1953. The source of this nitrate will be investigated in more detail in 1996.

Nitrate ranging from 15 to 200 mg L^{-1} NO_3^--N was detected near the water table at all piezometer nests located adjacent to a source of fertilizer or manure, where sands and silts occurred at ground surface (Figure 1). These locations included a feedlot, a manured field, a pivot corner adjacent to a location where manure was temporarily stored in 1993, and a minor depression adjacent to a cropped field. Surficial sands and silts at the two locations closest to the Oldman River (piezometer nests 11 and 16) contained less than 5 mg L^{-1} NO_3^--N. Low levels of faecal coliform were detected in groundwater at all locations where surficial sands and silts occurred adjacent to a source of manure. Repetitive monitoring indicates that nitrate adjacent to sources of manure does not usually occur at depths greater than about 3 m below the water table. The potential causes for the disappearance of nitrate with depth, including denitrification and barriers to downward groundwater flow, will be investigated in more detail in 1996.

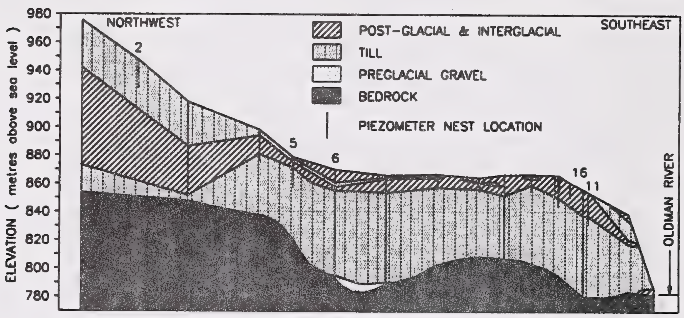

Figure 1. Geology along transect

Conclusions:

Recently-recharged groundwater flows mainly through surficial sands and silts. High nitrate that occurs in oxidized till and clay between 6 and 13 m below ground is not associated with high nitrate concentrations at the water table. Elevated nitrate and faecal coliform levels occur near the water table in surficial sands and silts adjacent to sources of manure. Deeper groundwater, and groundwater not adjacent to sources of manure, does not generally contain high levels of agricultural nitrate.

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WATER QUALITY

Nitrates in Soil and Groundwater below Irrigated Fields in Southern Alberta

Objectives:

1) To investigate the source and fate of groundwater nitrate in four irrigated areas in southern Alberta.
2) To determine the long-term effect of current agricultural practices on groundwater quality in the study areas.

Background:

The potential for nitrate released from fertilizer and manure to contaminate groundwater is dependent on site-specific conditions, including geology, recharge rates, and land-management practices. Agricultural nitrate has contaminated groundwater supplies in many areas of North America and Europe, but there is currently very little information regarding the potential for nitrate contamination of groundwater in the irrigated areas of southern Alberta.

Division Key Results:

This project will increase our understanding of the source and fate of nitrate in groundwater on irrigated land. The information will contribute to development of best management practices that minimize groundwater quality degradation.

Project Description:

The source and fate of nitrate are being studied at four irrigated fertilized study areas in southern Alberta. The study was initiated in 1993 and will be completed in 1997.

A basin in the Bow River Irrigation District was instrumented with piezometer nests (wells installed to test the groundwater at different depths) at 20 locations along a 10-km transect from immediately northeast of Vauxhall north to the Bow River. The basin-scale study area has generally been irrigated since the 1920s, and commonly-grown crops include potatoes, corn, sugar beets and cereal grains.

Piezometer nests have also been installed at three cropped sites to obtain more detailed information on nitrate source and fate. Site 1 is a quarter section owned and managed by a local farmer, and cropped mainly to soft wheat. Site 1 is located within the basin-scale study area. Commercial fertilizer has been applied since 1979, at rates recommended by soil testing. Site 2 has received an annual nitrogen fertilizer application of 112 to 168 kg N ha^{-1} since 1978, and has been devoted to a rotation of corn, sorghum and potatoes. Site 3 has been the location of field trials of nitrogen fertilizer rates varying from 0 to 200 kg ha^{-1} since 1987, and cropped to a rotation of soft wheat and oats. The geology at all four sites consists of a veneer to blanket of lacustrine materials over oxidized glacial till.

Project Results:

Groundwater nitrate greater than 10 mg L^{-1} NO_3^--N occurs in shallow groundwater at depths less than 6 m at all 18 sampled locations on Sites 2 and 3, at maximum levels of 325 and 125 mg L^{-1} NO_3^--N, respectively. Nitrate in the shallow groundwater at some locations appears to be increasing with time. Monthly monitoring suggests elevated nitrate levels in groundwater at Sites 2 and 3 are starting to reach depths of 5 and 7 m, respectively. Nitrate levels in soil above the water table are consistent with levels in groundwater. Tritium levels indicate this shallow groundwater recharged since 1953.

Groundwater nitrate ranging from 100 to 500 mg L^{-1} NO_3^--N occurs between about 6 and 20 m in oxidized till at several monitoring locations in the basin-scale study area and at Site 1. The very high levels of nitrate were associated with high nitrate at the water table only in groundwater discharge locations. The presence of agricultural nitrate in shallow groundwater at Site 1 cannot be determined on a purely geochemical basis, because discharge gradients appear to carry deep nitrate up to the water table. Groundwater with high nitrate does not generally contain tritium, suggesting that much of the groundwater in the high-nitrate zones recharged before 1953. These nitrate levels have generally been stable since the late 1970s, with minor fluctuations.

Conclusions:

Nitrate was commonly detected in shallow groundwater below two irrigated fertilized fields, at maximum levels of 300 mg L^{-1} NO_3^--N. Repetitive monitoring suggests that nitrate has been leached to depths up to 5 to 7 m, and that nitrate is increasing with time at some locations. Nitrate ranging from 100 to 500 mg L^{-1} NO_3^--N was commonly detected between about 6 and 20 m in oxidized till at many locations in the basin-scale study area and at Site 1. The nitrate does not appear to be coming directly from the ground surface. The source and fate of nitrate will continue to be investigated in 1996, using additional field testing, measurements of nitrous oxide, organic carbon, stable isotopes of hydrogen, oxygen and nitrogen, and groundwater flow and transport modelling.

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Supporting Agencies:

Canada-Alberta Environmentally Sustainable Agriculture Agreement

WATER QUALITY

Rainfall and Runoff from a Cattle Feedlot

Objectives:

The objective of this study is to obtain an understanding of the relationship between precipitation and runoff events occurring on feedlot pen areas. Project goals include the quantification of runoff yield, to properly size runoff storage lagoons and evaluate the quality of runoff water.

Background:

There is increased attention focused on intensive livestock operations. With the recent history of hog lagoon failures in North Carolina, proper sizing of runoff storage lagoons for Alberta feedlots is a design issue. In addition there are limited data describing the quantity and quality of feedlot runoff in Alberta. Odours, runoff and manure re-use are the principle concerns. Feedlot runoff contains nutrients, bacteria, faecal material, and sediments, and has a high chemical oxygen demand (COD). The quality of runoff from cattle holding areas cannot be examined without the full understanding of hydrologic conditions. These conditions are not only affected by the intensity or amount of rainfall, but also by the conditions of holding areas in terms of capacity and moisture condition.

Division Key Results:

The goals of our study include 1) to protect surface water quality, 2) to maintain competitive unit production costs, and 3) to preserve Alberta's reputation as a producer of high quality food and fibre in an unpolluted environment. This project is complementary to a larger study assessing the impacts of large scale, intensive livestock operations on water quality.

Project Description:

Highland Feeders Ltd. has a modern 18,000 head feedlot north of Vegreville, Alberta. The feedlot is constructed of four separate but similar sections with two rows of pens back to back. The area between pens is used as a cattle sorting alley as well as a drainage route. Feedbunks and roadways were built along the outside of the pens. From the feedbunks the pens slope toward the drainage route (sorting alley) which in turn, moves the runoff to the holding pond.

A model 207C temperature and humidity probe collects weather data while a Ota Keiki Seisakusho tipping bucket rain gauge collects rainfall data. The temperature, relative humidity and rainfall data are stored on a Campbell Scientific CR10 datalogger. A class 'A' evaporation pan provides evaporation data. V-notch weirs in culverts and water level recorders measure runoff samplers collect samples during runoff events from the pen areas. Hydrologic parameters such as the storm intensity, lag, peak runoff, average discharge, runoff yield and SCS curve number of each rainfall-runoff event were computed.

Additionally, storms were characterised on the basis of their return periods, to project runoff levels for future storm productivity.

Project Results: Preliminary results from the analyses of rainfall and runoff data from a cattle feedlot generated valuable information. The observed runoff hydrographs are complex figures with multiple peaks mimicking the patterns of rainfall distributions, unlike regular, single peak storm hydrographs from large streams. Only storms with return periods greater than or equal to 10 years provided meaningful data to characterize the hydrology of the pen area. Mean duration of lag between the initiation of rainfall and the commencement of runoff is approximately one day. Runoff yield, defined as the percentage of total runoff volume to total rainfall volume, ranges between 15 and 40% with a mean of almost 30%. The average SCS curve number for two pen areas is approximately 70, which is significantly lower than the SCS curve number (85-95) usually recommended for feedlots.

Conclusions: Measurable results were obtained from storms with a return period greater than or equal to 10 years. Lag time between rainfall and runoff was one day. Mean runoff yield was approximately 28% and the average SCS curve number was 68. Rainfall can be used to estimate runoff (depth and volume) and SCS curve numbers. Additional data are required to predict runoff yield.

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Supporting Agencies: Canada-Alberta Environmentally Sustainable Agriculture Agreement
Alberta Cattle Commission (ACC)
Northeastern Conservation Connection (NECC)
Highland Feeders Limited

CONSERVATION - CROPPING AND TILLAGE

Comparison of Legume Based, Continuous Cropping and Fallow Rotations on Soil Quality and Productivity

Objective:	To compare five three-year rotations and evaluate changes in soil properties and in N-fixing rhizobia bacteria populations.
Background:	When tillage is reduced, crop rotations become more important in reducing disease and insect problems. The economic value of crop rotations in the Peace River Region needs to be documented as a tool in farm management decisions. Different crops have different effects on crop residue levels, nitrogen use, and soil quality. Long-term effects on soil quality are not documented in the Peace Region. The survival rate of rhizobia populations between host crop years is not well known.
Division Key Result:	This project will contribute to improving soil quality by assessing the value of continuous cropping compared to fallowing, and the value of crop rotation versus monoculture cropping. It will also assess the value of adding pulse crops into the rotation.
Project Description:	This project began in 1992, when plots were seeded on oat greenfeed stubble. Baseline soil samples were taken prior to seeding. Plots are monitored for fertility, weeds, yields, emergence. Five three-year wheat (w) based rotations are being compared. These include w-w-w, w-w-fallow, w-w-peas, w-w-canola, w-w-green manure (red clover). The results from this site at Fairview will be combined with results from two other sites at Ft. Vermilion and Beaverlodge. Varieties used in 1995 were Carneval peas, Horizon canola, and CDC Teal wheat.
Project Results:	In 1993, yields were less variable than in 1992. In 1994, wheat did not benefit from the higher amounts of N added, and yields were reduced due to less favourable moisture than 1993. In 1992, 1994 and 1995 peas on wheat stubble yielded equal to or better than wheat in all rotations. In two years out of three, wheat on pea stubble yielded equal to wheat on fallow. In all three years, wheat on pea stubble outyielded wheat on wheat stubble. Competition from the clover when underseeded with wheat, and in the year following the clover green manure reduced wheat yields in that rotation in 1993.

Crop Yields					
Treatment	**1992**	**1993**	**1994**	**1995**	**Ave**
Wheat on Oats	34				
Wheat on Wheat		52	25	42	40
Wheat on Peas		56	29	50	45
Wheat on Canola		59	29	43	44
Wheat on Clover		40	32	47	40
Wheat on Fallow		69	30	50	50
Canola on Oats	15				
Canola on Wheat		39	20	24	28
Peas on Oats	38				
Peas on Wheat		53	45	57	52

Conclusions: The information from this site so far indicates that there are yield advantages to crop rotations with peas compared to continuous wheat. 1995 is only the first completion of the three-year cycle, while 1993 and 1994 were partial cycles. Soil quality parameters have not yet been analysed following this first cycle. At these levels of production, peas in rotation are resulting in lower levels of fertilizer input both in the year of pea production and in the following year of wheat. Results from this site need to be combined with the results of the sites managed by Agriculture and Agri-Food Canada at Beaverlodge and Ft. Vermilion to draw more general conclusions.

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Fairview Applied Research Association (FARA)

CONSERVATION - CROPPING AND TILLAGE

Direct Seeding of Field Peas

Objectives:	To see if direct seeding of field peas is feasible and evaluate new and upcoming direct seeding systems for field pea production.
Background:	In 1994, as an initial screening test, we evaluated four pea cultivars under three different tillage systems (conventional, minimum, and direct seeded). The four cultivars seeded were Montana, Highlight, Radley, and Patriot. This screening test was performed on black chernozemic soil located in Edmonton. Three herbicide treatments were included in this test: PURSUIT, BASAGRAN and a control (no herbicide). The test showed that direct seeded field peas significantly outyielded peas seeded under conventional and minimum tillage.
Division Key Results:	There are many possible benefits involved with the direct seeding of field peas. Topsoil becomes less prone to erosion by wind and water. Soil moisture is conserved and soil tilth is improved. Input costs (such as fuel, equipment maintenance and labour) may be reduced.
Project Description:	This two-year research project is conducted at two sites, Edmonton and Warburg. The field peas are inoculated and seeded into barley stubble under three different tillage systems (conventional, minimum and direct seeding). Each tillage block is split by four cultivars. The four cultivars seeded are Highlight, Montana, Patriot, and Radley. The plots are further split by five herbicide treatments: BASAGRAN, PURSUIT, a new herbicide by Cyanamid called P263 (not registered), EDGE, and a control treatment. BASAGRAN, PURSUIT and P263 were all applied as post-emergents whereas EDGE was fall applied. EDGE was soil incorporated into the minimum and conventional plots; however, on the direct seeded plots the EDGE was surface applied without incorporation. The following measurements are recorded each year: soil fertility in fall, soil temperature and soil moisture in spring at the time of seeding, precipitation throughout the growing season, crop emergence counts two and four weeks after seeding, weed counts just before incrop spraying and two weeks after, crop growth stages bi-weekly as well as dry matter yields, and yield samples. All yield data are analysed using an analysis of variance (ANOVA) with a split-split plot design.
Project Results:	There were no significant differences between tillage treatments at the Edmonton site, nor at the Warburg site, in 1995. At Edmonton the direct seeded treatments yielded 2396.40 kg/ha, the minimum tillage treatments yielded 2382.75 kg/ha, and the conventional tillage treatments yielded 2356.46 kg/ha.

There were some significant differences between cultivar yields at the Edmonton site. Highlight (2785.51 kg/ha) yielded significantly higher than Patriot (2241.20 kg/ha) and Radley (1891.30 kg/ha). There was no significant difference between Montana (2596.15 kg/ha) and Patriot. Radley yielded significantly lower than Highlight and Montana.

There were some significant differences between cultivar yields at the Warburg site as well. Highlight (2716.93 kg/ha) and Patriot (2663.94 kg/ha) yielded significantly higher than Montana (2279.00 kg/ha) and Radley (2171.52 kg/ha).

The new herbicide P263 (not registered) worked well at both sites. P263 controlled the volunteer barley in Edmonton and the wild oats at Warburg. Yields from the P263 treatments were significantly higher than yields from the EDGE, BASAGRAN and the control treatments.

Conclusions:

This study shows that direct seeding of field peas is feasible. When moisture levels are low, direct seeded peas can yield significantly higher than conventional and minimum tillage systems as was the case in the 1994 initial screening test. In 1995, there was no significant difference between tillage treatments. The new herbicide P263 appears to be well suited for direct seeding of field peas as yields were significantly higher than yields from the EDGE and BASAGRAN herbicide treatments at both sites. Yields from the P263 treatment were significantly higher than yields from the PURSUIT treatment at the Warburg site; however, there was no significant difference between the yields from the P263 and PURSUIT treatments at the Edmonton site.

We expect the yields from the EDGE herbicide treatments to be much higher in 1996 than the yields that were achieved in 1995. We were not satisfied with the granular applicator that was used to apply EDGE during the fall of 1994. We used a different applicator to apply the EDGE during the fall of 1995 and more accurate application rates were achieved.

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CONSERVATION - CROPPING AND TILLAGE

Sustainable Cropping Systems Research Study

Objectives: To study the effect of various crop rotations on soil quality and crop productivity, by comparing wheat yields from seven different rotations that include wheat. To compare the effect of conventional tillage versus low disturbance direct seeding.

Background: This long-term crop rotation study was designed, a site chosen and prepared in 1991 and the rotations commenced in 1992. The site is located just outside of the Town of Three Hills and was chosen because the site represents a Dark Brown to Thin Black transition soil zone. This site represents a significant portion of Alberta farmland where previous rotation studies were not conducted.

Division Key Results: This study is intended to complement other study sites that are part of the Alberta Agricultural Research Institute (AARI) Sustainable Cropping Systems Research Study Group. Producers will be able to use information generated from the study to decide which management system is best for their operation.

Project Description: The experimental design consists of 20 main plots per each of the three replicate blocks. The 20 main plots are randomly assigned and each represent a specific phase of one of the nine specific crop rotations assessed in the study. The nine crop rotations are as follows:

- #1- Continuous wheat
- #2- Canola - barley - peas - wheat
- #3- Wheat - fallow
- #4- Wheat - green manure (peas)
- #5- Wheat - wheat - fallow
- #6- Peas - wheat - fallow
- #7- Continuous brome grass
- #8- Continuous alfalfa and brome grass
- #9- Wheat - peas and oats silage - fall rye

Each rotation treatment is split by two tillage treatments: conventional tillage and direct seeding.

Project Results: The 1995 yield data were collected, analysed and recorded as planned. All agronomic weather data, from the fully operational weather station, have been sorted and recorded. The following data were analysed using ANOVA - forage and grain yields, forage and grain N,P,K,S levels, soil moisture levels at the time of seeding, fall soil nutrient levels (available N,P,K,S) after harvest. Eight wheat yields (as well as their available N,P,K,S levels) were analysed to compare among the seven different wheat rotations and their effect on soil quality.

The average wheat yields from rotation #2 (canola-barley-peas-wheat) were 3707.8 kg/ha and rotation #4 [green manure (peas)-wheat] were 3569.8 kg/ha. The wheat yields from rotations #2 and #4 were significantly higher than the wheat yields from rotation #1 (continuous wheat) which were 2654.6 kg/ha. No other significant differences in wheat yields were observed. No significant differences were observed among the wheat yields between the conventional tillage and direct seeding treatments.

Only one significant difference resulted from the analysis for available macro-nutrient levels among the eight different wheat treatments. Available phosphate levels for the wheat grown in rotation #6 (peas-wheat-fallow) was 8.57 kg/ha, which was significantly higher than the phosphate levels in rotation #6 (wheat-wheat-fallow) which was 4.07 kg/ha.

During the spring of 1995 rotation #8 (continuous alfalfa and brome grass) had 239.2 mm of stored soil moisture which was significantly lower than the amounts of stored soil moisture in the following six treatments: the wheat treatments of rotation #6 (348.3 mm), the pea treatments in rotation #2 (346.6 mm), the wheat treatments grown after the fallow in rotation #5 (341.5 mm), the fallow plots in rotation #3 (338.7 mm), the wheat treatments in rotation #4 (330.4 mm), and the continuous wheat treatments in rotation #1 (329.5 mm). The amount of 1995 rainfall was below the 30-year averages for each month of the growing season other than July.

Conclusions: A few important conclusions can be generated from the analysis of the 1995 grain yields among the eight different wheat treatments. The wheat grown in the canola-barley-peas-wheat and green manure-wheat rotations significantly outyielded wheat grown in the continuous wheat rotation. Rotations which involved fallow treatments did not have a significant increase in their wheat yields. It appears that rotations with an appropriate balance of cereal, oilseed, and pulse crops, while minimizing summer fallow are more productive than cereal monocultures such as continuous wheat.

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CONSERVATION - CROPPING AND TILLAGE

Direct Seeding Herbicide-Tolerant Canola

Objectives:	Evaluate the use of ROUNDUP-, PURSUIT-, and Glufosinate-tolerant canolas under a direct seeding system. Help adapt direct seeding technology for the growing of canola.
Background:	The conventional weed control strategies used when growing canola generally include soil incorporated herbicides. There are some promising developments in herbicidal weed control that would fit well with direct seeding. Herbicides can be used successfully under direct seeding as a post-emergent application on herbicide-tolerant canola cultivars.
Division Key Results:	This project will contribute to improving soil quality by developing crop production practices that conserve soil. Direct seeding herbicide-tolerant canolas will benefit the producer's land by eliminating the need for soil incorporated herbicides. The soil will be protected from wind and water erosion and have improved soil moisture.
Project Description:	This project was conducted in 1995 and may be repeated in 1996. The project was conducted on barley stubble at two sites within central Alberta - a Gray soil near Warburg that was direct seeded for years, and a deep Back soil at the University of Alberta Research Station in Edmonton. A split-split plot design was used with three replicates at each site. The main plots were conventional tillage and direct seeding (ROUNDUP 1 L/acre prior to seeding). There were four canola cultivars: PURSUIT-tolerant, ROUNDUP-tolerant (only in Edmonton) and Glufosinate-tolerant canola, and a conventional canola. At Warburg the conventional canola was Legacy and at Edmonton it was Excel 6. Six different herbicide treatments were applied as follows: control (no post-emergent herbicide), POAST+MUSTER, ROUNDUP, Glufosinate, PURSUIT, and a new PURSUIT (AC 299,263). All seeding was done with a Harmon airdrill with hoe openers. Warburg and Edmonton were seeded at 8 lbs/acre on May 18 and May 23 respectively. The post-emergent herbicides were applied at their recommended rates. Weed counts, ratings and square metre yield samples were taken.
Project Results:	At both sites the direct seeded treatment had higher canola yields than the conventional treatment but it was not significant. In Edmonton the average yield on the direct seeded and conventional treatments were 2.43 t/ha and 2.42 t/ha respectively. At Warburg the yield was 1.41 t/ha and 1.39 t/ha for the direct seeded and conventional treatments respectively.

The canola yields for the different cultivars from 1995 are summarized in Table 1.

Table 1. Average canola yield for each cropping system in 1995

Canola Cultivar	Herbicide	Edmonton Yield (t/ha)	Warburg Yield (t/ha)
Conventional	Control POAST+MUSTER	2.02 b 2.40 ab	0.58 c 1.77 a
Liberty Link	Control POAST+MUSTER Glufosinate	2.05 b 2.37 ab 2.23 ab	0.59 a 1.46 ab 1.40 ab
Pursuit Smart (1471)	Control POAST+MUSTER PURSUIT AC 299,263	1.98 b 2.78 a 2.55 ab 2.47 ab	0.87 bc 2.11 a 1.82 a 1.98 a
Roundup Ready (R73)	Control POAST+MUSTER ROUNDUP	2.60 ab 2.86 a 2.81 a	not seeded not seeded not seeded

In each column, values followed by the same letter are not significantly different at P=0.05.

The Edmonton site did not have any wild oats at harvest but there was volunteer barley. The Warburg site had lots of wild oats and volunteer barley. Weed control ratings were taken at both sites.

Conclusions:

Using herbicide-tolerant canolas in a direct seeding systems gives canola yields similar to a conventional system. Under direct seeding, no pre-seeding tillage operations are needed and these post-emergent herbicides give good weed control. These post-emergent herbicides, for the herbicide-tolerant canolas, also have canola yields that are not significantly different than yields from the POAST+MUSTER treatment. The ROUNDUP- tolerant canola was only seeded at Edmonton. The yields were impressive but another year of research is needed to compare all these herbicide-tolerant canolas in a direct seeding system.

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United Grain Growers
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CONSERVATION - CROPPING AND TILLAGE

Canola and Direct Seeding

Objectives:

To help adapt direct seeding technology for the growing of canola. To evaluate the use of post-emergent applied PURSUIT and fall applied granular EDGE when used in a direct seeding system for canola production. To give sound advice to producers who wish to use direct seeding for canola production.

Background:

Two aspects of the agriculture industry in western Canada have increased greatly over the past few years: the amount of canola grown and the use of direct seeding methods. Most of the direct seeded acreage was cereal crops and not canola. The reason is that most herbicides for canola production generally require tillage to incorporate the herbicide in the soil. For example, Trifluralin (TREFLAN) and Ethylfluralin (EDGE) both require soil incorporation. Weed control options for direct seeding of canola are lacking; however, there are some promising developments in herbicides that would fit well with direct seeding systems.

Division Key Results:

This research will satisfy the need for information required by farm managers on how to direct seed canola. This project combines the growing success of direct seeding technology with leading edge developments in selective weed control for canola. Canola yields could increase due mostly to improved moisture conservation under direct seeding as compared to conventional tillage. Input costs could be reduced due to lower labour costs, less fuel usage, and decreased investment in tractors and equipment. Direct seeding will also decrease the amount of topsoil eroded by wind and water.

Project Description:

This research project was conducted at two sites, Edmonton and Warburg. Canola was seeded into barley stubble under two different tillage systems (conventional and direct seeded). Each tillage block is split by two canola cultivars: a non-PURSUIT-tolerant cultivar and a PURSUIT-tolerant cultivar. The plots are further split by five herbicide treatments: EDGE, PURSUIT, POAST plus MUSTER, a new herbicide by Cyanamid called P263 (not registered), and a control treatment. EDGE, PURSUIT and P263 were all applied as post-emergents whereas EDGE was fall applied. EDGE was soil incorporated in the conventional plots; however, on the direct seeded plots EDGE was surface applied without incorporation. All of the data collected were analysed using an analysis of variance (ANOVA) with a randomized complete blocks plot design.

Project Results:

The canola yield analysis resulted in no significant differences between the two tillage systems at the Edmonton site, nor at the

Warburg site. At Edmonton the direct seeded treatments had an average yield of 1660.0 kg/ha, and the conventional treatments yielded an average of 1715.5 kg/ha. At Warburg the average yield for the direct seeded treatments was 1539.3 kg/ha, and the conventional treatments averaged 1706.2 kg/ha.

There were significant differences in canola yields among the different cultivar and herbicide treatments at both locations. At Edmonton the conventional canola (Legacy) yielded 1044.2 kg/ha which was significantly lower than all of the remaining treatments' yields. There were no other significant differences among the remaining canola yields in Edmonton. At Warburg, the PURSUIT-tolerant cultivar sprayed with P263 yielded significantly higher than all of the remaining treatments. See Table 1 for the canola yields at Warburg.

Table 1. Canola yields at Warburg (kg/ha)*

Canola type:	P263	PURSUIT	EDGE	POAST & MUSTER	Control
Pursuit Tol.	2445 (a)	1694 (b)	1614 (b)	1877 (b)	1110 (cd)
Legacy	Nil	Nil	1604 (bc)	1671 (bc)	969 (d)

* The information in parentheses denotes significant differences between treatments, a different letter means that there was a significant difference.

Conclusions:

The results show that direct seeding of canola is feasible. The new Cyanamid herbicide (P263) appears to be very well suited for direct seeding of canola. We expected EDGE treatments to achieve much higher yields. We were not satisfied with the granular applicator that was used to apply EDGE in the fall of 1994. The applicator did not distribute the granular EDGE uniformly due to the rough field surface. We used a more reliable applicator to apply EDGE during the fall of 1995 and are repeating this experiment in 1996.

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CONSERVATION - CROPPING AND TILLAGE

Direct Seeding Barley, Peas and Canola into Pasture Sod

Objectives: Document whether or not no-till seeding of barley, canola, or peas into pasture or hay land is feasible. Compare the economics of no-till seeding to conventional methods.

Background: The costs involved in converting hay or pasture fields into field crop production are high. Intense tillage operations such as ploughing, heavy discing, and cultivations are needed. These tillage operations cause the fields to become susceptible to wind and water erosion. There is increased producer interest in converting hayland into a field crop using direct seeding practices.

Division Key Results: This project will contribute to improving soil quality by using soil conservation practices. Direct seeding into sod will benefit the producer's land by protecting the soil from wind and water erosion and improving soil moisture management. A best management practice for direct seeding into sod will be developed.

Project Description: This project is a follow-up to a two-year study and 1995 was the first year of this project. Each site had three tillage treatments replicated four times in a randomized complete block design. The three tillage systems evaluated were:

1. Split fall and spring applied ROUNDUP with 0.75 L/acre of ROUNDUP and 0.24 L/acre of 2,4-D in early fall 1994, and 0.75 L/acre of ROUNDUP one week before seeding, no-till seeding and post emergent spraying.
2. Spring applied ROUNDUP (1.5 L/acre) one week before seeding, no-till seeding and post-emergent spraying.
3. Ploughing (fall 1994) followed by three disc operations, one pass with cultivator and harrows, seeding and post-emergent spraying.

On each treatment, three species were seeded: Brier (barley), Colt (canola), and Carneval (peas). Each species was subdivided to compare a John Deere 750 series disc drill to a Harmon airdrill with hoe-type openers. This project is at two sites within central Alberta: a pasture field near Warburg, and an old hay field on the University of Alberta Research Station in Edmonton. All tillage systems were seeded on the same day. Warburg and Edmonton were seeded June 1 and 2, 1995.

Project Results: In 1993 and 1994, we compared barley direct seeded into sod (1 L/acre of ROUNDUP applied each spring), with a conventional ploughed system. In the first year, grass regrowth in the no-till plots significantly reduced crop yields to about 70% of yields from the conventional plots. By the second year (1994) the no-till plots yielded higher than the conventional plots.

In 1995, barley direct seeded into sod (with ROUNDUP applied the previous fall) had grain yields to about 94% of yields from the conventionally ploughed plots with no significant difference in yields. Edmonton's fall sprayed treatment had 80 bu/ac and Warburg had 100 bu/ac. Both treatments had 60 kg/ha of nitrogen applied at time of seeding.

The pea grain yields in Edmonton were significantly higher in the fall sprayed treatment (50 bu/ac) compared to the ploughed treatment (30 bu/ac). At Warburg the pea yields on the fall sprayed plots (32 bu/ac) were significantly lower than the ploughed treatment (42 bu/ac). However, there was no significant difference in pea yield between the spring sprayed (36 bu/ac) and ploughed treatment (42 bu/ac).

At Edmonton, canola seeded into the fall sprayed (24 bu/ac) or spring sprayed (15 bu/ac) treatment yielded significantly lower than the ploughed treatment (29 bu/ac). At Warburg there was no significant difference between treatments. We had poor penetration of the John Deere drill and, as a result, very poor yields.

The Harmon airdrill had significantly higher grain yields than the John Deere disc drill when seeding canola and peas in Edmonton. At both sites there was no significant difference in grain yield between the two drills when seeding barley.

Conclusions:

When seeding barley, fall spraying gives significantly higher grain yields than spring spraying. Spring spraying can leave the barley more susceptible to numerous fungal diseases such as Scald. Scald was more abundant on the spring sprayed plots than the fall sprayed plots. Direct seeded peas into pasture sod had yields comparable to the conventionally ploughed treatment at Edmonton. At Warburg the direct seeded pea yields were slightly lower than the conventional treatment. The canola yields were poor in this first year of study. A second year of research is needed and this project will be repeated in 1996.

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CONSERVATION - SOIL MOISTURE MANAGEMENT

Effect of Stubble Height on Moisture Conservation, Soil Temperature & Yield

Objectives:

To compare the effect of four treatments, swathed (short) stubble with the stubble chopped and spread, swathed (short) stubble with the straw removed, tall stubble, and alternate height stubble on soil moisture, soil temperature and crop yield.

Background:

Due to prolonged drought in southeastern Alberta during the 1980s, much interest arose in the moisture conservation aspects of stubble management. The Chinook Applied Research Association initiated a project in 1993 to compare practical ways of managing stubble by monitoring their impact on spring soil moisture and temperature, crop performance and economic feasibility. This is year three of an eight-year study. Because of the crop-fallow rotation, 1995 was the first year that crop performance can be compared with the treatments.

Division Key Results:

This project will help improve soil quality by identifying sustainable management practices that will reduce the risk of poor residue cover brought about by drought.

Project Description:

The site is located six miles south of Acadia Valley in a Brown Chernozem with heavy clay lacustrine parent material. The cropping practice is spring wheat-fallow in a strip cropping pattern.

The project design initially provided for 12 plots (4 replicates x 3 treatments) in the stubble strip and 12 additional plots in the next chemfallow strip. As the rotation moves from fallow to crop, instruments can be easily moved from one plot layout to another. This allows yearly data collection from 1995 through to the conclusion of the project in 1999. A fourth treatment, short stubble with straw removed, was added in the fall of 1995.

Project Results:

Weather conditions from 1993 through 1995 represent a high degree of contrast. Fall 1993 resulted in wet field conditions and the winter produced ample snowcover until mid-March. Spring 1994 was warmer and considerably drier than normal. Fall 1994 resulted in generally dry field conditions and winter snowcover was sparse. Spring 1995 was cool, but precipitation was near normal for most of the growing season. The alternate height strips trapped more snow, based on snow water content, than the other treatments during the 1993-94 winter. The short stubble trapped the least. Despite this, the overwinter soil moisture gains were lowest in the alternate height treatment and similar in the short and tall stubble in the spring of 1994 and 1995. The differences were significant in the spring of 1994 in the top 30 cm (Table 1).

Near-surface soil temperatures were similar in all treatments during the early spring of 1994 and 1995. The treatment differences were within 0.5°C of each other. The short stubble was significantly cooler below the 50 cm depth however.

The alternate height plots had significantly lower yields than the other treatments in 1995. These plots also had the lowest nitrate-N levels but similar spring soil moisture. The tall stubble plots had similar yields and nitrate-N levels to the short stubble (Table 2).

Table 1. Overwinter soil moisture gains in the top 30 cm, Acadia Valley plots

	TALL	SHORT	ALTERNATE HEIGHT
Overwinter gain (mm) 93-94*	9.9[a]	10.6[a]	4.0[b]
Overwinter gain (mm) 94-95*	19.3[a]	18.0[a]	12.3[a]
Precipitation (Nov 93-May 94)		70 mm	
Precipitation (Nov 94-May 95)		79 mm	

* different letters indicate significant difference between treatments at 5% level (Tukey's studentized range test).

Table 2. Average yields of hard red spring wheat on fallow, spring nitrate-N levels and spring soil moisture for three stubble treatments, 1995

	TALL	SHORT	ALTERNATE HEIGHT
Yield (kg/ha)*	3.08[a]	2.99[a]	2.55[b]
Spring soil moisture (mm/m)	399	380	386
Spring NO_3-N (ppm)*	39.5[a]	32.5[ab]	25.0[b]
Precipitation (May-Sept 95)		204 mm	

* different letters indicate significant difference between treatments at 5% level (Tukey's studentized range test).

Conclusions:

Alternate height stubble has shown lower overwinter soil moisture gains than the short or tall stubble during both a wet fall/average winter and a dry fall/dry winter. The treatment will trap more snow, when ample snowcover occurs, but this does not translate into a soil moisture gain. Investigation is ongoing to determine the nature of the treatment effect resulting in the lower yields in the alternate height treatments.

The similarity of conditions between the short and tall stubble have caused the team to re-examine stubble handling in the area. The short stubble treatments have had the straw chopped and spread evenly over the surface. In this area of limited snowcover, the mulch created in the short stubble may conserve moisture as effectively as tall stubble. The new treatment, with the straw baled and removed, is designed to address this question.

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CONSERVATION - SOIL MOISTURE MANAGEMENT

An Evaluation of Moisture and Temperature Differences Between Direct and Conventional Seeding Systems in the Black Soil Zone

Objective:	To compare seedbed soil moisture, soil temperature and crop performance differences between conventional and reduced tillage systems in the Black Soil Zone.
Background:	Concerns have been raised by producers in the Black Soil Zone about cool seeding temperatures under reduced tillage systems. There have also been very little relevant data to address these concerns. This project was initiated in 1995 to develop data and gain an increased understanding of soil moisture and temperature behaviour in order to address these concerns.
Division Key Results:	This project will contribute to improving soil quality by increasing the understanding of soil moisture and temperature behaviour under direct seeding conditions. This will help producers make better decisions regarding adoption of direct seeding.
Project Description:	This was the first year of the study. Two sites were chosen, one south of Ft. Saskatchewan and the other at the Parkland Agriculture Research Initiative (PARI) Demonstration Farm. Resources will be concentrated on the Ft. Saskatchewan site because of the relatively uniform field conditions. The data from the PARI Farm will be used in a supportive role. Fields at both sites were instrumented to monitor spring soil moisture in both conventional tilled and minimum tilled areas. Soil temperature was monitored to compare differences at depths of 2, 5 10, 20, 50 and 100 cm. Within seed row vs between row temperatures differences were instrumented for comparison at the Ft. Saskatchewan site. Soil moisture samples were taken at seeding and two weeks after seeding. More detailed monitoring of soil moisture is planned for 1996.
Project Results:	Results for 1995 show that during this year, the minimum tilled site at Ft. Saskatchewan had similar soil moisture at seeding but higher soil moisture two weeks later, during a prolonged dry spring. The minimum tilled field also had higher yields than the conventional. Comparison of this field with other fields managed by the Sturgeon Soil Savers showed that higher soil moisture and higher yields were measured in two of three other fields in the area. The early spring was cooler than normal. The conventional till fields were warmer than the reduced till fields throughout the period of measurement at both sites. The difference was generally 1 °C except for the week prior to seeding when the conventional till soil warmed faster than the zero till. At Ft. Saskatchewan the

temperature difference at seeding (May 11) was 3°C. In the week following seeding the zero till warmed faster than the conventional till resulting in a 1° C difference by May 17.

The between row areas were warmer than the seedrow by 0.5°C at seeding. This increased to a 1.0°C difference by late May. The temperatures were identical from the starting date (April 22) until disturbed at seeding. The differences are the same for both the zero till and the conventional till areas.

Conclusions:

The preliminary results show that following seeding in 1995, the reduced tillage systems conserved soil moisture better than the conventional tillage during the prolonged dry spring. The higher yields under reduced tillage reflect this trend.

Conventional tillage sites were consistently warmer by about 1°C; however this does not appear to have resulted in any significant advantage to the crop growth. Most temperature differences resulted in a one- to three-day advantage for the conventional till.

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Sturgeon Soil Savers
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CONSERVATION - SOIL MOISTURE MANAGEMENT

An Investigation of the Potential for Using Ground Penetrating Radar to Measure Bulk Rootzone Soil Moisture

Objective: This study provided an initial assessment of Ground Penetrating Radar (GPR) for measuring areas of varying but known soil moisture content. The GPR data were compared to neutron probe data and gravimetric data at the same field positions.

Background: Soil moisture availability is the most limiting factor to crop growth on the Canadian Prairies. Measurement by conventional methods is not well suited for monitoring or mapping purposes. GPR offers the potential for a quick, easy and non-destructive technique for measuring bulk rootzone soil moisture. Empirical relationships between ground wave velocity and soil moisture content need to be determined and tested however. If consistent relationships can be established, GPR can be used to obtain numerous measurements over large areas which will allow rapid assessment of moisture content and the field variability.

Division Key Results: Soil moisture data are essential for modelling erosion, runoff, leaching, and crop production. This project will help improve soil quality and water quality by identifying the potential for this method to accurately measure soil moisture.

Project Description: A non-irrigated corner of a site at SE 2-10-21-W4, six miles northeast of Lethbridge, was selected and partitioned into three areas. The areas were wetted with sprinklers for 12 hours (approximately 150 mm water applied), 8 hours (approximately 100 mm) and 4 hours (approximately 50 mm). The water was applied in the fall, after the soils had been dried from crop water use. Rain gauges were set at several areas to measure the amount of water actually applied.

Four days after the irrigation, soil moisture content was measured at 0-30 cm, 30-60 cm, 60-90 cm, 90-120 cm, by gravimetric methods, and at corresponding depths with the neutron probe. GPR measurements were taken using 200 MHz and 100 MHz frequencies.

Ground wave velocities (GVW) were compared to three sets of soil moisture data for each depth range, gravimetric moisture content (H_2O wt), gravimetric corrected with bulk density data (H_2O vol), and neutron probe data (H_2O np). Regression analysis was used to assess the strength and nature of the velocity - moisture relationships.

Project Results:	The GPR ground wave velocities at 100 MHz frequency data correlated strongly with near surface moisture data, but weakened considerably with depth. The 200 MHz data did not correlate with any depth and results for this frequency are not discussed. Correlations were strongest between the GVW and H_2O wt, similar between GVW and H_2O vol, and slightly lower between GVW and H_2O np. Correlations between GVW and H_2O wt were also strongest in the top 30 cm range ($r^2=0.88$) but decreased at the 30-60 cm range ($r^2=0.29$). No correlation was observed at deeper ranges. Combining the depth ranges strengthened correlations at depth but not enough to draw significance in the 0-90 cm and 0-120 cm ranges.
Conclusions:	The results show that GPR has considerable potential for bulk soil moisture measurements for the top 30 cm and some potential for the top 60 cm. Ground wave velocities at 100 MHz correlated strongly with soil moisture in the top 30 cm but weakened with depth. Lower frequencies have more potential for sensitivity to deeper soil layers, and an assessment of the GPR ground waves at 50 MHz and 25 MHz is recommended.
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CONSERVATION - DRYLAND SALINITY

Salinity Mapping Using Integrated GPS Positioning and Navigation Techniques

Objectives:

Develop a salinity mapping system utilizing satellite based positioning and navigation techniques.

Background:

Mapping the extent and intensity of salt-affected agricultural land was time consuming, labour intensive and expensive in the past. Development of instruments such as electromagnetic meters like the EM38 and EM31 have reduced these inputs. Previous developments were of a mechanical nature. They included manual surveys of transect and grid lines and implementation of a mechanical switching mechanism to log data.

Sampling points were determined by assigning specific values based on a local coordinate system. Data logging software recorded X, Y values and assigned corresponding salinity data. With developments in satellite positioning technology, salinity information can be integrated into Geographic Information Systems (GIS).

Division Key Results:

Comprehensive databases can be integrated into GIS systems and used as a benchmark for ongoing research and development.

Project Description:

The development of an EM38/GPS navigation system is designed to provide sub-metre accuracy for positioning of data and sampling points. The location of these positions would then be recorded and returned to for future sampling. Four sites were chosen for developing the system. The first site (Crossfield) is used in the Salinity Prediction Study. Intensive monitoring over recent years has resulted in the collection of a large amount of salinity data. This information can be used as a benchmark for future study.

Three sites are in the Milk River area. The Balog farm is the site of a previous investigation and part of a whole farm management project. The last two sites, both in township 2, are part of a watershed study. Mapping was conducted in October 1995, at all sites using a prototype GPS radio navigation system. This included a radio link for the purpose of broadcasting real time position corrections. This is necessary for the light bar to operate. The light bar is calibrated to keep the operator within a metre of the predetermined grid or transect lines.

Soil sampling sites representing the range of EM38 values are located. These sites are used for comparing EM38 values to saturated paste electrical conductivity values. The position of these sites are recorded for the purpose of returning for subsequent sampling and analysis.

Project Results:

The system worked well under field conditions. The EM38 takes 16 readings per second and the GPS takes one reading per second. This results in intensive evaluation. The data include elevations as well as salinity. These data are used to generate salinity intensity as well as three dimensional topographic maps.

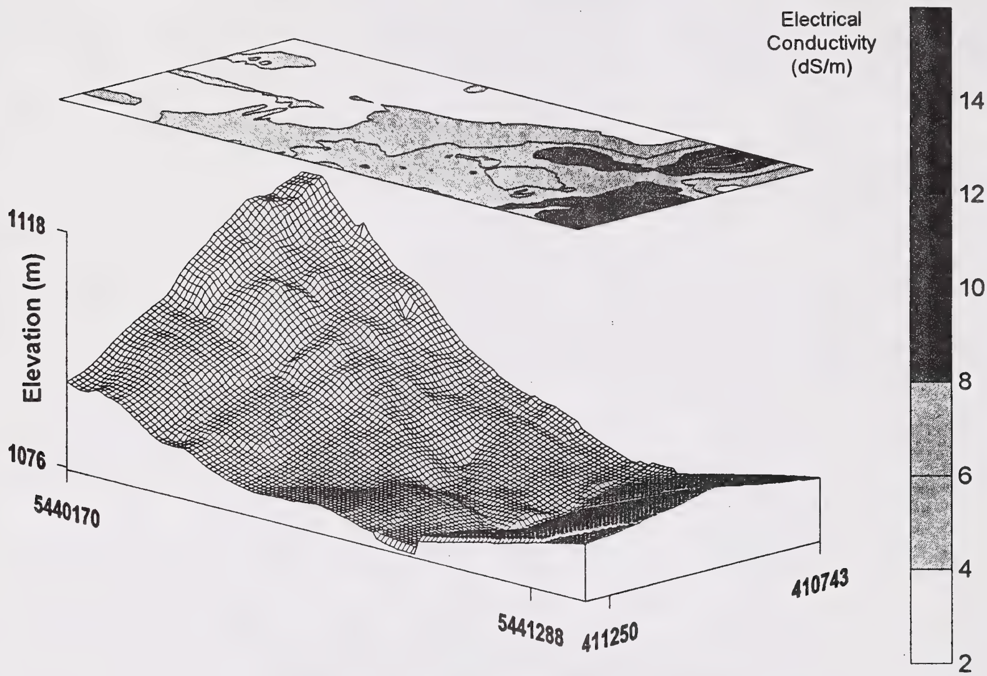

Figure 1. Salinity over 3D topographic map

Conclusions:

The integration of a GPS radio navigation system has improved the capabilities and potential of salinity mapping. Large tracts of agricultural land can be assessed accurately. Mapping time has been greatly reduced, yet more data are available to process.

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CONSERVATION - DRYLAND SALINITY

Yield, Rooting Depth and Soil Water Use of Alfalfa in the Dark Brown Soil Zone of Alberta

Objectives:

To evaluate 12 alfalfa cultivars to develop reliable recommendations on yield, rooting depth and soil water use for soil salinity control.

Background:

Alfalfa can control dryland salinity by reducing local groundwater flow to saline seeps. However, different alfalfa cultivars differ markedly in rooting depth, soil water extraction and yield. As well, each cultivar performs differently in different soil zones. To improve adoption of alfalfa for salinity control, producers need to know which alfalfa cultivars give the best salinity control along with the highest yields. Current recommendations on alfalfa cultivars for salinity control are based on research done in Montana before 1980, when many of today's improved varieties were not available.

Division Key Results:

This project will contribute to improving soil quality by encouraging alfalfa production. Alfalfa production will benefit the producer's land and the surrounding landscape by controlling salinity, reducing soil erosion and adding soil nitrogen and organic matter.

Project Description:

The Dark Brown soil zone site is located at the Lethbridge Agriculture Centre (S½ 3-9-21 W4). Plots were seeded in 1994 with 12 varieties of alfalfa, randomized and replicated four times. One fallow plot was established in each replication to serve as a control. Each of the plots were 2 m by 6 m in size. Each plot was instrumented with a centrally located, 6 m long by 5 cm diameter aluminum access tube to allow for the reading of soil moisture at depth. Soil moisture was read monthly throughout the growing season using the neutron scatter technique. Readings were taken at 25 cm, 50 cm and every 50 cm thereafter to a depth of 600 cm. Each plot was harvested on two occasions in 1995 and dry matter yields were determined. Rooting depth and soil water use analyses are based on the mean value from four plots, from six sampling dates, for each cultivar. Graphs of soil moisture at depth for each variety were plotted along with the fallow treatment soil moisture. The intersection of the fallow and moisture use lines indicates rooting depth. The area from the 25 cm depth to the intersection point was planimetered to determine soil water use.

Project Results:

Figure 1 presents yield, rooting depth and soil water use for each of the 12 alfalfa varieties evaluated. Performance is presented as a percentage of Beaver. AC Blue J yielded the

highest with a two cut, dry matter total of 10385 kg/ha. Rangelander extracted the most soil moisture at 592 mm. Rangelander rooted deepest to a depth of 350 cm.

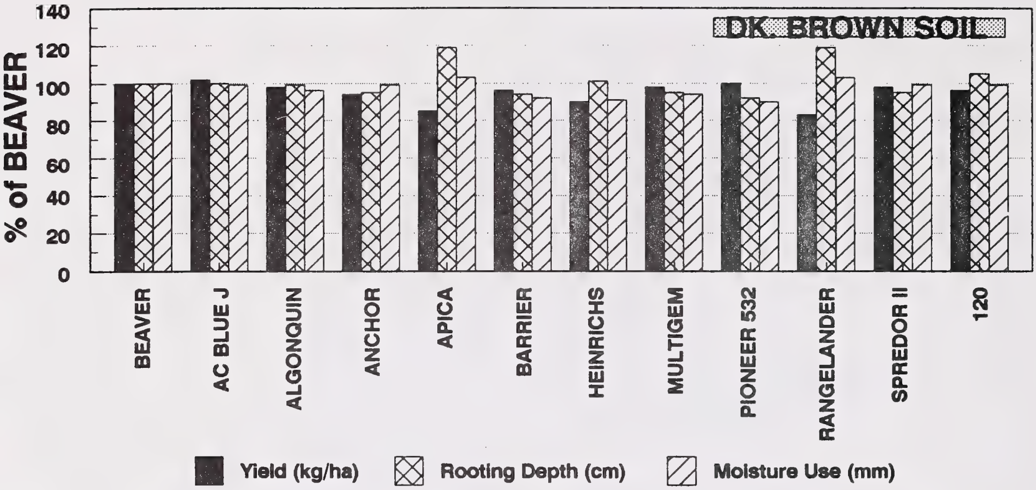

Figure 1. Yield, rooting depth and soil water use for 12 alfalfa varieties in the Dark Brown soil zone.

Conclusions:

After one complete growing season (1995), preliminary data are available on the yield, rooting depth and soil water use of 12 varieties of alfalfa in Alberta's Dark Brown soil zone. This data set will become more complete in subsequent years as the individual performance of each variety becomes more distinct.

The selection of the most suitable alfalfa cultivar will provide optimum control of shallow groundwater and hence, the most rapid control and reclamation of salt-affected land. As well, it will be possible to realize the highest possible economic net return from the land. Determination of yield, rooting depth and moisture use for 12 alfalfa cultivars on the basis of soil zone will provide much needed, statistically verifiable information. Such data may give insight into selection criteria for development of new alfalfa cultivars for this specific purpose.

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Funding Sources:

Canada-Alberta Environmentally Sustainable Agriculture Agreement

Yield, Rooting Depth & Soil Water Use of Alfalfa in the Brown Soil Zone of Albert

Objectives:

To evaluate 12 alfalfa cultivars to develop reliable recommendations on yield, rooting depth and soil water use for soil salinity control.

Background:

Alfalfa can control dryland salinity by reducing local groundwater flow to saline seeps. However, different alfalfa cultivars differ markedly in rooting depth, soil water extraction and yield. As well, each cultivar performs differently in different soil zones. To improve adoption of alfalfa for salinity control, producers need to know which alfalfa cultivars give the best salinity control along with the highest yields. Current recommendations on alfalfa cultivars for salinity control are based on research done in Montana before 1980, when many of today's improved varieties were not available.

Division Key Results:

This project will contribute to improving soil quality by encouraging alfalfa production which will benefit the land and the surrounding landscape by controlling salinity, reducing soil erosion and adding soil nitrogen and organic matter.

Project Description:

The Brown soil zone site is located adjacent to the Chinook Applied Research Association facility (NE 34-27-4 W4) in the Town of Oyen. Plots were seeded in 1994 with 12 varieties of alfalfa, randomized and replicated four times. Plot sizes are 2 m by 6 m and a fallow plot was established in each replication to serve as a control. Each plot was instrumented with a centrally located, 6 m long by 5 cm diameter aluminum access tube to allow for the reading of soil moisture at depth. Soil moisture was read monthly throughout the growing season using the neutron scatter technique at 25 cm, 50 cm and every 50 cm thereafter to a depth of 600 cm. Each plot was harvested twice in 1995 and dry matter yields were determined. Rooting depth and soil water use analyses are based on the mean value from four plots, from six sampling dates and for each cultivar. Graphs of soil moisture at depth for each variety were plotted along with the fallow treatment. The intersection of the fallow and moisture use lines indicates rooting depth. The area from the 25 cm depth to the intersection point was planimetered to determine soil water use.

Project Results:

Figure 1 presents yield, rooting depth and soil water use for each of the 12 alfalfa varieties evaluated. Performance is presented as a percentage of Beaver. Rangelander yielded the highest with a two cut, dry matter total of 17617 kg/ha. Algonquin extracted the most soil moisture at 582 mm. Pioneer 532 alfalfa rooted deepest to a depth of 252 cm.

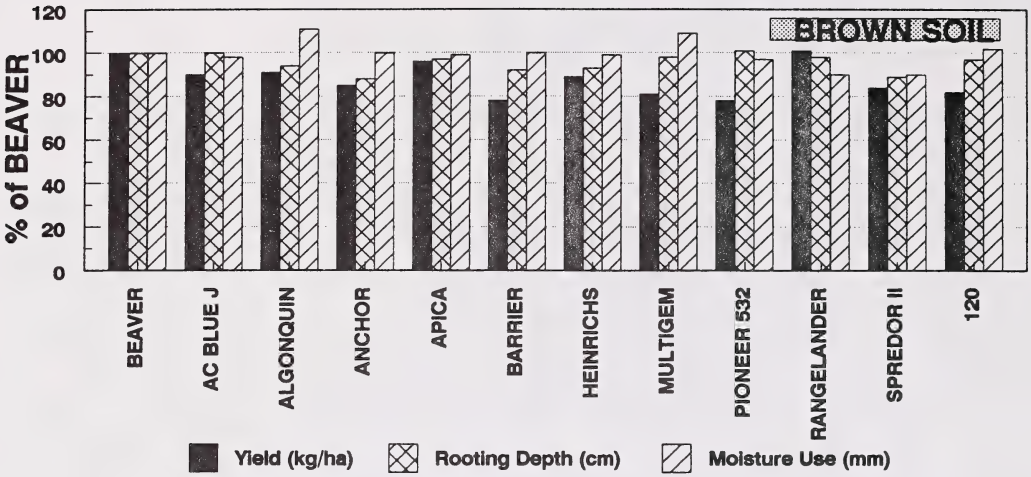

Figure 1. Yield, rooting depth and soil water use for 12 alfalfa varieties in the Brown soil zone.

Conclusions:

After one complete growing season (1995), preliminary data are available on the yield, rooting depth and soil water use of 12 varieties of alfalfa in Alberta's Brown soil zone. This data set will become more complete in subsequent years as the individual performance of each variety becomes more distinct.

The selection of the most suitable alfalfa cultivar will provide optimum control of shallow groundwater and hence, the most rapid control and reclamation of salt-affected land. As well, it will be possible to realize the highest possible economic net return from the land. Determination of yield, rooting depth and moisture use for 12 alfalfa cultivars on the basis of soil zone will provide much needed, statistically verifiable information. Such data may give insight into selection criteria for development of new alfalfa cultivars for this specific purpose.

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CONSERVATION - DRYLAND SALINITY

Yield, Rooting Depth & Soil Water Use of Alfalfa in the Black Soil Zone of Alberta

Objectives: To evaluate 12 alfalfa cultivars to develop reliable recommendations on yield, rooting depth and soil water use for soil salinity control.

Background: Alfalfa can control dryland salinity by reducing local groundwater flow to saline seeps. However, different alfalfa cultivars differ markedly in rooting depth, soil water extraction and yield. As well, each cultivar performs differently in different soil zones. To improve adoption of alfalfa for salinity control, producers need to know which alfalfa cultivars give the best salinity control along with the highest yields. Current recommendations on alfalfa cultivars for salinity control are based on research done in Montana before 1980, when many of today's improved varieties were not available.

Division Key Results: This project will contribute to improving soil quality by encouraging alfalfa production. Alfalfa production will benefit the producer's land and the surrounding landscape by controlling salinity, reducing soil erosion and adding soil nitrogen and organic matter.

Project Description: The Black soil zone site is located on the Parkland Agriculture Research Initiative (PARI) Farm (N 9-53-16 W4) approximately 80 km east of Edmonton. Plots were seeded in 1994 with 12 varieties of alfalfa, randomized and replicated four times. One fallow plot was established in each replication to serve as a control. Each of the plots were 2 m by 6 m in size. Each plot was instrumented with a centrally located, 6 m long by 5 cm diameter aluminum access tube to allow for the reading of soil moisture at depth. Soil moisture was read monthly throughout the growing season using the neutron scatter technique. Readings were taken at 25 cm, 50 cm and every 50 cm thereafter to a depth of 600 cm. Each plot was harvested on two occasions in 1995 and dry matter yields were determined. Rooting depth and soil water use analyses are based on the mean value from four plots, from six sampling dates, for each cultivar. Graphs of soil moisture at depth for each variety were plotted along with the fallow treatment soil moisture. The intersection of the fallow and moisture use lines indicates rooting depth. The area from the 25 cm depth to the intersection point was planimetered to determine soil water use.

Project Results: Figure 1 presents yield, rooting depth and soil water use for each of the 12 alfalfa varieties evaluated. Performance is presented as a percentage of Beaver. Apica yielded the highest with a two cut, dry matter total of 6758 kg/ha. AC Blue J extracted the most soil moisture at 387 mm. Heinrichs rooted deepest to a depth of 215 cm.

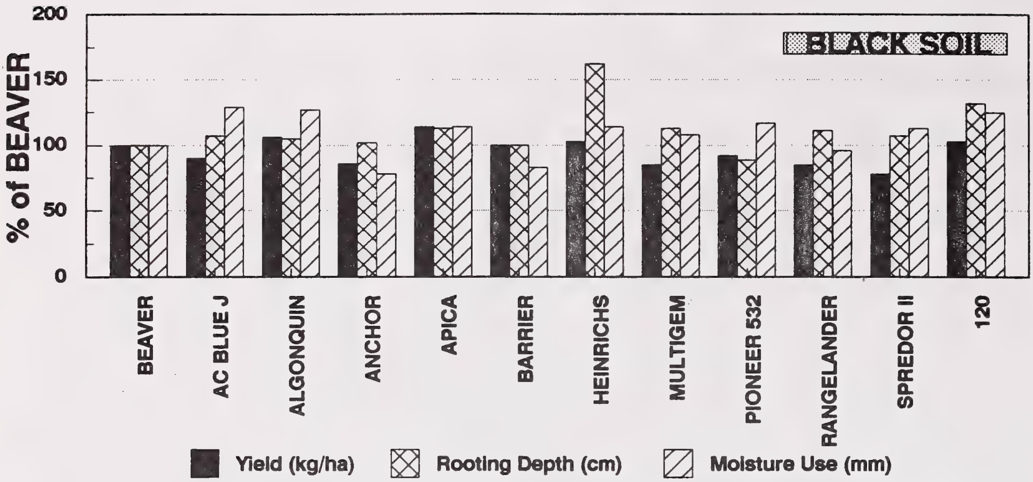

Figure 1. Yield, rooting depth and soil water use for 12 alfalfa varieties in the Black soil zone.

Conclusions:

After one complete growing season (1995), preliminary data are available on the yield, rooting depth and soil water use of 12 varieties of alfalfa in Alberta's Black soil zone. This data set will become more complete in subsequent years as the individual performance of each variety becomes more distinct.

The selection of the most suitable alfalfa cultivar will provide optimum control of shallow groundwater and hence, the most rapid control and reclamation of salt affected land. As well, it will be possible to realize the highest possible economic net return from the land. Determination of yield, rooting depth and moisture use for 12 alfalfa cultivars on the basis of soil zone will provide much needed, statistically verifiable information. Such data may give insight into selection criteria for development of new alfalfa cultivars for this specific purpose.

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CONSERVATION - HYDROLOGY

Water Erosion Prediction Study, WEPP Validation

Objectives: To evaluate and adapt the WEPP model under Alberta conditions for development of best management practices which reduce soil and water degradation.

Background: The USDA Water Erosion Prediction Project (WEPP) model uses a new generation of water erosion prediction technology. The model can predict the location, and magnitude of soil loss and/or deposition within a watershed or on a hillslope for a given management system. It can also assess or select the best management practices that effectively control water erosion. Residue management and tillage operations, for example, can have profound effects on the magnitude of water erosion. The extent to which these factors influence soil erosion varies on different soils and different landscapes, and it is difficult to assess their impact without expensive long-term field studies. The WEPP model application is an attractive alternative approach.

Division Key Results: Adoption and usage of the model will help to develop management practices which reduce water erosion under Alberta conditions.

Project Description: Four water erosion measurement sites have been established within the main Alberta landscape and soil regions. The existing sites are located near Tofield, Breton, Lacombe, and Grande Prairie. These sites are instrumented with fully automated climate stations, and runoff and soil loss measuring devices. The climate stations record air and soil temperatures, relative humidity, wind speed and direction, solar radiation, rainfall and snow amounts. Other measurements include crop residue levels, canopy cover and height, surface roughness, soil moisture, bulk density, crop yield and amount of biomass. All data from the monitoring sites will be used to evaluate performance of the water erosion prediction models under Alberta soil and climate conditions.

Project Results: Runoff and soil loss data were collected for the spring snowmelt and summer storm events in 1995. Both events were small and generated soil loss rates below 1 t/ha/year.

WEPP simulations were conducted on silty clay soils from the Peace River region of Alberta using different landscapes and tillage practices. This was to determine the minimum residue levels required to control water erosion below 9 t/ha/year. In the simulations, it was assumed that 9 t/ha/year is sustainable soil loss. In the following table, for example, conventional tillage on a 50 m long slope causes 9 t/ha/year soil loss when there is zero residue on the soil surface and the slope steepness is 6.8%.

Table 1. Comparison of tillage, residue, slope length and steepness with tolerable soil loss

Slope Lengths (m)	Conventional Tillage		Reduced Tillage		Zero Tillage	
	Residue level (kg/ha)					
	0	3200	0	3200	0	3200
	Slope steepness (%)					
30	9.7	14	9.8	18.4	13	50
50	6.8	10	7.4	13.8	9	35
100	4.6	6.6	5.2	9.2	6.4	21

The same type of cultivation on a 10% slope requires 3200 kg/ha residue to maintain the same soil loss. A slope steeper than 10% requires an additional change in a farm practice from conventional tillage to reduced or zero tillage to maintain tolerable soil loss. These simulations showed, that the increase in the residue level from 0 to 3200 kg/ha without changing farm practice, may not be sufficient to control water erosion, especially on longer slopes. Further, it appears that residue cover impacts water erosion on a narrower range of the slope steepness when a field is under conventional tillage. The opposite is true when a farm practice is changed from conventional tillage to reduced, or zero tillage.

Conclusions:

Continued effort in building a data base for water erosion prediction model validation is recommended. The WEPP model is an inexpensive, fast method to evaluate residue levels, and conservation practices controlling water erosion.

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CONSERVATION - HYDROLOGY

Soil Erodibility Studies

Objectives: Evaluate equations used for predicting baseline soil erodibility parameters. Characterize and rank the erodibility of Alberta soils.

Background: The Water Erosion Prediction Project (WEPP) was developed in the United States. It is very sensitive to input soil erodibility values. During an erosion event, runoff often concentrates to form small channels (rills). Within rills, soil particles are detached through head-cutting, sidewall slumping and bed scour. Between the rills (interrill areas) soil particles are detached through raindrop impacts and transported to the rills in shallow flows. WEPP uses a set of equations to predict a soil's erodibility values for interrill erosion (K_i), rill erodibility (K_r) and the hydraulic shear within a rill below which no soil detachment occurs (τ_c). In order to confidently use WEPP in Alberta, these equations must be verified to account for the differences between the soils found in the United States, where the equations were developed, and the soils found within Alberta.

Division Key Results: WEPP can be used to select best management practices aimed at reducing soil losses and thus improving soil and water quality.

Project Description: Rill and interrill erodibility measurements began in the spring of 1995. To date, five sites have been tested. Over the next two years, up to 30 sites representing a broad range of Alberta soil types will be targeted for testing. Rill erodibility tests are conducted by constructing four small rill channels on a freshly cultivated soil surface. Rills are then subjected to five flow rates at 12, 19, 26, 33, 40 L min^{-1}. During each flow trial a series of sediment samples and rill cross-section measurements are taken. These data are used to solve the following equation and derive values for Kr and τ_c.

$$D_r = K_r(\tau - \tau_c) \qquad (1)$$

Where: D_r is the sediment detachment rate in the rill (kg m^{-2} s^{-1}), K_r is the rill erodibility of soil due to hydraulic shear (m s^{-1}), τ is the hydraulic shear of flowing water (Pa), calculated from rill cross-sections, and τ_c is the shear below which there is no detachment (Pa).

K_i is measured in the lab by collecting 100 kg of soil at each site. The soil is set in a metal frame 500 x 750 mm long and shaped to form side slopes of 50% which drain into a central channel. The soil is exposed to 25 minutes of simulated rainfall with an intensity of 60 mm h^{-1}. Runoff and sediment samples are collected. K_i is calculated by solving the following equation:

$$K_i = \frac{D_i}{\left(I \cdot R \cdot S_f\right)} \qquad (2)$$

Where: K_i is the interrill erodibility constant (kg s m^{-4}), D_i is the interrill delivery rate (kg m^{-2} s^{-1}), I and R represent rainfall intensity and runoff rate, respectively (mm h^{-1}), and S_f is a slope factor.

Project Results:

The following equations were derived from preliminary experimental data to show the relationship between WEPP predicted and measured erodibility parameters on Alberta soil types.

$$\tau_{c_{WEPP}} = 1.83 + 0.648\tau_{c_{measured}} \qquad R^2=0.91 \tag{3}$$

$$K_{r_{WEPP}} = 0.00348 + 0.90K_{r_{measured}} \qquad R^2=0.98 \tag{4}$$

$$K_{i_{WEPP}} = 2340529 + 3.19K_{i_{measured}} \qquad R^2=0.78 \tag{5}$$

All regressions were significant at the 0.05 level. However, the equations were based upon few (five) observations. As more data become available the equations may need modification. These findings suggest that existing WEPP equations adequately predict erodibility relationships on the soils tested. In addition, the methods developed in Alberta are suitable for gauging rill and interrill erodibility values for the soils tested.

Conclusions:

The findings from this study are encouraging. Upon completion of this study, the erodibility of Alberta soils will be adequately characterized so that WEPP simulations may be performed in Alberta with confidence. Furthermore, the erodibility data set generated in this study may be useful in many facets of conservation planning.

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CONSERVATION - FIELD SHELTERBELTS

Evaluation of Wind Reduction of a Two Row Poplar and Spruce Field Shelterbelt in Alberta (1995)

Objectives:

To measure the wind speed reduction and micro climate effect of different field shelterbelts to provide recommendations on the design and effectiveness of shelterbelts.

Background:

Field shelterbelts reduce the speed of the wind and trap drifting snow. This can reduce soil erosion and provide an enhanced growing environment for adjacent crops. The type of belt and its orientation will determine just how effective the belt is. Evaluating various shelterbelts in Alberta will provide a data base of information that will allow for better design recommendations.

Division Key Results:

This project will contribute to improving soil quality by encouraging the planting of new field shelterbelts and the maintenance of existing field shelterbelts. Established field shelterbelts will reduce soil erosion and improve crop yields.

Project Description:

In 1995 we evaluated the wind reduction of a two row poplar and spruce shelterbelt located near Penhold, Alberta. The field shelterbelt is oriented N-S and has 16 to 18 metre tall poplar trees along the east side and 6 metre tall spruce trees along the west side. The shelterbelt is 12 metres wide with the trees spaced at 2.4 metres in the row. The monitoring equipment was set up from August 15 to November 6, 1995. The equipment consisted of an array of anemometers placed in a line perpendicular and to east of the shelterbelt. The sensors were spaced at factor of the height (H) away from the shelterbelt as follows: 1H, 3H, 5H, 7H, 9H, 12H, 15H. The 15H location was assumed to be the open field or unsheltered value. A wind direction sensor was placed at 15H and a relative humidity and temperature sensor was installed at 3H and 15H. The 3H location was considered to be the most sheltered distance from the belt. All sensors were placed at one metre off the ground and were all tied into a datalogger programmed to register an input every 30 seconds, and calculate and store averages every 10 minutes. Relative wind speeds were calculated by dividing the speed at each distance by the speed at 15H.

Project Results:

Figure 1 shows the average results of the effect of an in-leaf and out-of-leaf two row poplar and spruce shelterbelt on leeward wind speeds. Both the in-leaf and out-of-leaf shelterbelt are effective at reducing the wind speed particularly in the 1H to 7H area. The maximum wind reduction is 58% in the 3H to 5H area for the in-leaf and 78% at 1H for out-of-leaf shelterbelt. The distance to 90% recovery of open field speed is 13.5H and 12H for in-leaf and out-of-leaf belt respectively. There is only a small difference between in-leaf and out-of-leaf shelterbelt due to the row of spruce trees that retains its foliage over winter.

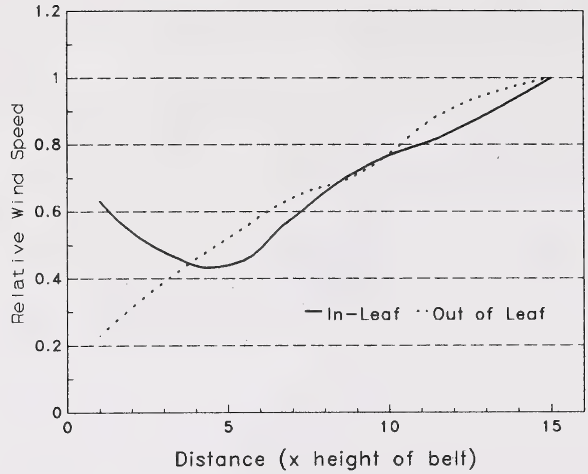

Figure 1. Relative wind speeds leeward of a two row poplar and spruce shelterbelt, in- and out-of-leaf (winds measured from the west ±56.25°)

There was an average air temperature of 11.08°C and a relative humidity of 63.22% during the daytime (8 am to 8 pm) for the sheltered location (3H). This compares to 10.58°C and 62.84% for the unsheltered location (15H). At night, the values were 3.22°C and 82.19% for 3H, and 3.82°C and 80.56% for 15H.

Conclusions:

The two row shelterbelt was very effective at reducing the wind speed by 40% or more out to seven times the height of the belt. For a 16 metre high poplar shelterbelt that amounts to a large area of protection. The spruce trees in this two row belt provide year round protection even when the poplar trees lose their leaves. The effect on the micro environment was small, but the trend shows higher daytime temperatures and relative humidity in the sheltered area. This may be favourable to high heat unit crops. Also the higher relative humidity may lower the evapotranspiration.

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CONSERVATION - FIELD SHELTERBELTS

Evaluation of Crop Yields Adjacent to Field Shelterbelts in Alberta (1995)

Objectives:

To measure crop response to field shelterbelts to provide recommendations on yield effect and economic returns of field shelterbelts.

Background:

Field shelterbelts are effective barriers to the wind thereby providing protection to the adjacent soil and crops. However, shelterbelts are a long-term investment of time and money, and farmers are slow to implement this conservation measure. Research in other parts of the world has show that, on average, improved yields adjacent to shelterbelts compensate for lost crop where the belt is planted as well as the zone of competition. It is important to investigate this under local Alberta conditions in order to effectively promote field shelterbelts in Alberta.

Division Key Results:

This project will contribute to improving soil quality by encouraging the planting of new field shelterbelts and the maintenance of existing field shelterbelts. Established field shelterbelts will reduce soil erosion and improve crop yields.

Project Description:

This project was started in 1990 and will be finished in 1996. In 1995, 55 spring seeded crops were harvested including wheat, oats, barley, peas, and canola. The sites were located in Brown, Dark Brown, Black, and Grey soil zones. Fields were sampled to the east, west, north, and south of field shelterbelts. Shelterbelt types included poplar, caragana, spruce, green ash, willow, native, and mixed belts.

The crops were sampled along three transects perpendicular to the shelterbelt. A 1 or 2 m^2 sample was harvested by hand at distances of 0.5, 1, 2, 3, 5, 7, 10, 15, 20, and 25 times the height (H) of the belt along each transect. All distances were measured from the centre of the shelterbelt (0H). The yield at each distance was calculated as a percentage of the assumed open field yield (average of 15H-25H) to give relative yields for each distance. All the data were analysed using analysis of variance.

Project Results:

Figure 1 shows the overall yield response curves for 1993, 1994, and 1995. The yield response curves show there was some yield increase in the 1.5 H to 15H area and a loss of yield in the area occupied by the belt and the competition zone from 0H to 1.5H. The average relative yield in the sheltered zone (0H-15H) in 1995 was 2% less than the open field yield. The curves for 1993 and 1994 show a slightly greater yield response than 1995 with a net sheltered yield of 1% less than open field yield. The lower response in 1995 may be due to a low snow accumulation over the winter of 1995 and more than adequate moisture over the growing season for most of the province. In 1995, 20 of the sites had average sheltered yields greater than the open field yield and ranged from a 1% to 27% increase.

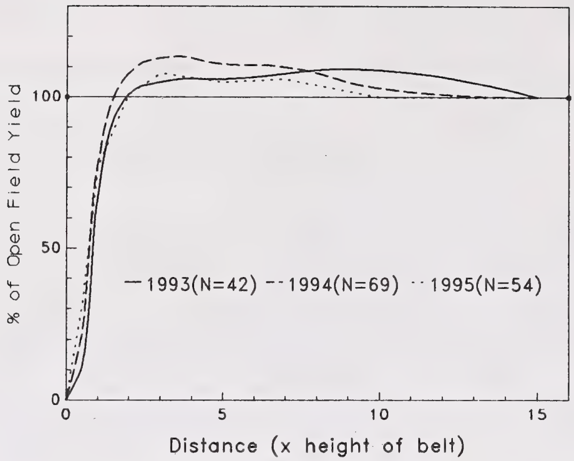

Figure 1. The overall effect of field shelterbelts on crop yields in 1993, 1994 and 1995.

Conclusions:

In 1995, there was on average 2% less yield in the sheltered area (0H-15H) than in the open field (15H-25H). If the sheltered area did not include the area occupied by the belt (0H-.5H), there would be a 1% increase over the open field. This shows that higher crop yields in the protected area (1.5H-15H) go a long way to compensate for the lost yield in the area occupied by the shelterbelt and zone of competition (0H-1.5H).

Results from 1995 will be combined with previous years' data for a comparison of yield response between crop species, belt types, soil zones, and field directions. This will allow for more accurate predictions of economic returns of field shelterbelts in Alberta.

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Alberta Agricultural Research Institute Regional On-Farm Demonstration Program

CONSERVATION - INDICATORS

Integration and Land Use: Demonstrating and Targeting Local Sustainable Land Management

Objectives:	To find practical ways of monitoring the rate of adoption of sustainable agriculture practices in support of conservation programs. The integration of topographic and vegetative data was the basis for identifying and monitoring sustainable agriculture practices.
Background:	The system described here is similar to the one developed and used by the United States Environmental Protection Agency (Thronton, Hyatt, and Chapman 1993). Data integration in an automated environment was carried out to examine linkages between land use activities and the physical landscape. By integrating a number of data sources in a geographic framework, we draw closer to the capability of showing farm managers the linkage between agricultural practices and sustainable land management. An integrated data source for evaluating sustainable agriculture practices would include linkages to terrain, remote sensing, soil and climate, census of agriculture, and farmer/crop surveys.
Division Key Results:	This work contributes to maintained/improved soil quality and/or water quality by providing computerized inventories for the selection and communication of best management practices. Examples include intensive livestock operation manure and runoff management, soil erosion control, soil salinity and organic matter loss.
Project Description:	A combination of GIS and image processing software (PC-ArcInfo, IDRISI, SAS, Paradox, and Lotus) was used to develop an integrated, sustainable agricultural data source. Regional data were organized according to Soil Landscape of Canada (SLC) polygons (Shields, et al. 1991) or Land System polygons (Brierley, Kwiatkowski, and Marciak 1992). Local data were often organized on the basis of the Alberta Township System. Some data (census of agriculture) sources could only be assigned at a regional level while other data could be assigned to multiple levels (terrain, remote sensing). Data integration was carried out at several locations in Alberta including a site south and east of Buffalo Lake in the County of Stettler. This county was chosen on the basis of data availability, presence of diverse agricultural activities and history of ongoing data collection.
Project Results:	Figure 1 demonstrates integration of land cover and terrain data with a view to identifying non-sustainable land cover changes as they occur in the landscape.

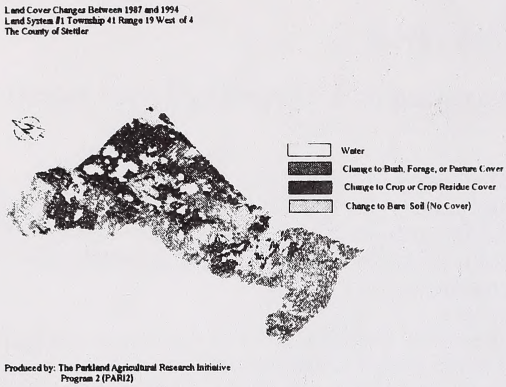

Figure 1. Integrated land cover & terrain data

Census and sample surveys tended to provide better answers to qualitative questions but are updated less often (every five years). Questions on such topics as the kinds of crops grown or the area under direct seeding in this SLC or that land system were best handled with census and survey data. Census data have been used in particular cases to provide agriculture production profiles of an area (Hiley, Marciak, Beever, and King 1994).

Remote sensing data were better at providing area estimates of general vegetation classes over much larger areas. Satellites data availability is generally more current than census or sample surveys, but data acquisition is variable. Most satellites still measure electromagnetic reflectance in the infrared, visible and ultraviolet spectrum and so often capture images that are obscured by cloud cover. Radar satellite data overcome this problem and will soon be in general use.

Conclusions:

Further effort must be spent constructing definitions of sustainable agriculture practices, and building an information framework in an operational setting that meets the needs of decision makers.

Change from permanent cover (bush land, native range, etc.) to cropping on an annual basis can be monitored over time with this procedure.

Regional scale vegetation and terrain information can be provided in digital format for implementing programs aimed at targeting agricultural soil erosion and sediment loading in streams (Snell 1984).

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